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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Past Diameters and Gross Volumes of Plains Cottonwood in Eastern Colorado

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Abstract

Bark thickness and past diameter relationships are developed for plains cottonwood in eastern Colorado. Tables of gross volume in cubic feet and point-sampling factors are presented for use in resource inventory.

Keywords: Forest measurement, tree volume tables, stand volume estimates, *Populus deltoides* var. *occidentalis*.

The increasing local demand for wood fiber and forest products has led to examination of forest resources along the South Platte and Arkansas Rivers and other streams in the eastern plains of Colorado. Bark thickness, past diameter, gross volume in cubic feet, and point-sampling relationships presented here were developed as part of a study of extensive inventory procedures applicable to plains cottonwood (*Populus deltoides* var. *occidentalis Rydb.*).

The cottonwood forest of the South Platte River basin in Morgan County was selected as the primary study area. This forest along the river bottom covers an area approximately 0.75 mile wide by 45.6 miles long. Orchards, shelterbelts, and ornamental plantings were excluded from the study.

Sample trees were measured by personnel of the Colorado State Forest Service.

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Bark Thickness and Past Diameters

Past diameters of trees on temporary plots can be used to determine periodic changes in basal areas and volumes.

Diameter growth is the result of increase in thickness of both wood and bark. Both must be accounted for in relating present diameters outside bark to equivalent past diameters. Measurements of diameter outside bark and average periodic radial growth of wood are needed. Bark thickness often is not measured, since it can be estimated from relationships determined in advance.

The relationships presented below were computed from data obtained from 225 cottonwoods in the study area. Present diameters at breast height were measured to the nearest 0.1 inch with a diameter tape, and bark thickness was measured to the nearest 0.05 inch with a bark-measuring instrument at two points on each tree. Tree diameters ranged from 1.6 to 47.4 inches.

The following prediction equations relating diameter inside bark (d.i.b.) to diameter outside bark (d.o.b.) were computed by simple linear regression:

$$\text{d.i.b.} = -0.086 + 0.892\,(\text{d.o.b.}) \quad [1]$$
$$\text{d.o.b.} = 0.151 + 1.118\,(\text{d.i.b.}) \quad [2]$$
$$r = 0.998$$

Past d.i.b. may be expressed as a function of present d.o.b. by subtracting twice the radial wood growth (r.w.g.) from both sides of equation 1 as shown in equation 3:

$$\text{Past d.i.b.} = -0.086 + 0.892\,(\text{present d.o.b.}) - 2.0\,(\text{r.w.g.}) \quad [3]$$

By substituting equation 3 into equation 2, the following equation for past d.o.b. can be derived:

$$\text{Past d.o.b.} = 0.055 + 0.996\,(\text{present d.o.b.}) - 2.235\,(\text{r.w.g.}) \quad [4]$$

Past diameters can then be computed directly using equation 4.

Gross Volume Table

Because little supervised cutting has been done in the cottonwood forests of eastern Colorado, the volume table presented here is based on measurement of standing trees. A Spiegel relascope was used to measure outside bark diameters at 4-foot intervals starting at the top of a hypothetical 0.5 foot stump up to a 2-inch-diameter top. These measurements were taken on the main stem and all major branches of each of 159 sampled trees. The d.i.b. relation (equation 1) was tested at points along the stem and branches of 10 trees to insure that the relation held for diameters measured at other than breast height. No discrepancies were found, so equation 1 was used to convert d.o.b. measurements to d.i.b.

Values presented in table 1 were computed from the regression equation:

$$\ln V = -6.5534 + 1.0636 \ln (D^2H) \quad [5]$$
$$r = 0.96$$

where: V = gross volume in cubic feet,
D = d.o.b. in inches at breast height,
H = total height in feet.

Diameters listed in table 1 are the midpoints of each 1-inch class, and heights listed are the midpoints of 10-foot classes. The block in table 1 indicates the extent of basic data.

Point-Sampling Factors

Point sampling factors expressed as volumes in cubic feet per square foot of basal area (B) were computed using the following equation derived from equation 5:

$$V/B = 0.2613\,(D^2H)^{1.0636}/D^2$$

Values given in table 2 for combinations of measured tree diameter and height can then be used in efficient point-sample cruising for volume.[3] Volume per acre is computed as follows:

1. Multiply the number of trees counted through the prism or relascope in each diameter-height class by the class point-sampling factor given in table 2.
2. Sum the results of step one.
3. Multiply this total by the basal area factor of the prism or angle gage used and divide by the number of points sampled in the stand.

Time and effort can often be saved if only height of counted trees are measured, while diameters are estimated by broad diameter classes. This savings is possible because volume per square foot of basal area does not vary greatly among trees in a single height class in table 2.

[3]*Myers, Clifford A., and Carleton B. Edminster. 1972. Volume tables and point-sampling factors for Engelmann spruce in Colorado and Wyoming. USDA For. Serv. Res. Pap. RM-95, 23 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.*

Table 1.--Gross volumes in cubic feet inside bark for plains cottonwood in eastern Colorado.

Diameter breast height outside bark	Total height in feet								Basis
	10	20	30	40	50	60	70	80	no. trees
Inches	----------Volume in cubic feet----------								
5	.51	1.06	1.63						3
6	.75	1.56	2.40	3.26					5
7	1.04	2.16	3.33	4.52	5.74	6.96			9
8	1.38	2.88	4.43	6.01	7.62	9.25	10.90		14
9	1.77	3.69	5.69	7.72	9.79	11.89	14.00		7
10		4.62	7.12	9.66	12.25	14.87	17.52		7
11		5.66	8.72	11.83	15.00	18.22	21.46		11
12		6.81	10.49	14.24	18.06	21.92	25.83		2
13		8.08	12.43	16.88	21.41	25.99	30.62		8
14		9.46	14.56	19.77	25.06	30.43	35.85		13
15		10.95	16.86	22.89	29.02	35.24	41.51		4
16		12.56	19.34	26.26	33.30	40.42	47.62	54.89	14
17		14.29	22.00	29.88	37.88	45.99	54.18	62.45	4
18		16.14	24.85	33.74	42.78	51.93	61.18	70.52	8
19		18.11	27.87	37.85	47.99	58.26	68.64	79.12	7
20		20.20	31.09	42.22	53.52	64.98	76.55	88.24	8
21		22.41	34.49	46.83	59.38	72.08	84.93	97.89	8
22		24.74	38.07	51.70	65.55	79.58	93.76	108.07	2
23		27.19	41.85	56.83	72.05	87.47	103.06	118.79	4
24		29.77	45.82	62.22	78.88	95.76	112.82	130.04	3
25		32.47	49.97	67.86	86.04	104.45	123.06	141.84	2
26		35.29	54.32	73.77	93.53	113.54	133.77	154.18	5
27			58.86	79.93	101.34	123.03	144.95	167.07	1
28			63.60	86.36	109.49	132.93	156.61	180.51	2
29				93.05	117.98	143.23	168.75	194.50	0
30				100.01	126.80	153.94	181.37	209.04	1
31				107.24	135.96	165.06	194.47	224.15	0
32				114.73	145.46	176.59	208.06	239.81	0
33				122.49	155.30	188.54	222.13	256.03	2
34				130.52	165.49	200.90	236.69	272.82	0
35				138.83	176.01	213.68	251.75	290.17	1
36				147.40	186.88	226.88	267.30	308.09	0
37				156.24	198.10	240.49	283.34	326.58	3
38				165.36	209.66	254.53	299.88	345.64	1
39						268.99	316.91	365.28	0
40						283.87	334.45	385.49	0
Basis no. trees	3	13	29	47	38	23	6	0	159

Derived from: $\ln V = -6.5534 + 1.0636 \ln (D^2H)$

Merchantable stem (excluding 0.5-foot stump) and branches to 2-inch diameter.

Diameters listed are midpoints of 1-inch classes.

Heights listed are midpoints of 10-feet classes.

Block indicates extent of basic data.

Table 2.--Gross volumes in cubic feet per square foot of basal area for plains cottonwood in eastern Colorado.

Diameter breast height outside bark	Total height in feet							
	10	20	30	40	50	60	70	80
Inches	-Cubic feet-							
5	3.7	7.8	11.9					
6	3.8	7.9	12.2	16.6				
7	3.9	8.1	12.5	16.9	21.5	26.1		
8	3.9	8.2	12.7	17.2	21.8	26.5	31.2	
9	4.0	8.4	12.9	17.5	22.2	26.9	31.7	
10		8.5	13.1	17.7	22.5	27.3	32.1	
11		8.6	13.2	17.9	22.7	27.6	32.5	
12		8.7	13.3	18.1	23.0	27.9	32.9	
13		8.8	13.5	18.3	23.2	28.2	33.2	
14		8.8	13.6	18.5	23.4	28.5	33.5	
15		8.9	13.7	18.7	23.6	28.7	33.8	
16		9.0	13.8	18.8	23.8	28.9	34.1	39.3
17		9.1	14.0	18.9	24.0	29.2	34.4	39.6
18		9.1	14.1	19.1	24.2	29.4	34.6	39.9
19		9.2	14.2	19.2	24.4	29.6	34.9	40.2
20		9.3	14.2	19.3	24.5	29.8	35.1	40.4
21		9.3	14.3	19.5	24.7	30.0	35.3	40.7
22		9.4	14.4	19.6	24.8	30.1	35.5	40.9
23		9.4	14.5	19.7	25.0	30.3	35.7	41.2
24		9.5	14.6	19.8	25.1	30.5	35.9	41.4
25		9.5	14.7	19.9	25.2	30.6	36.1	41.6
26		9.6	14.7	20.0	25.4	30.8	36.3	41.8
27			14.8	20.1	25.5	30.9	36.4	42.0
28			14.9	20.2	25.6	31.1	36.6	42.2
29				20.3	25.7	31.2	36.8	42.4
30				20.4	25.8	31.4	36.9	42.6
31				20.5	25.9	31.5	37.1	42.8
32				20.5	26.0	31.6	37.2	42.9
33				20.6	26.1	31.7	37.4	43.1
34				20.7	26.2	31.9	37.5	43.3
35				20.8	26.3	32.0	37.7	43.4
36				20.8	26.4	32.1	37.8	43.6
37				20.9	26.5	32.2	37.9	43.7
38				21.0	26.6	32.3	38.1	43.9
39						32.4	38.2	44.0
40						32.5	38.3	44.2

Derived from: $V/B = 0.2613 (D^2 H)^{1.0636} / D^2$

Diameters listed are midpoints of 1-inch classes.

Heights listed are midpoints of 10-feet classes.